

LOW-FREQUENCY RADIO OBSERVATORY PATHFINDER ON THE NEAR-SIDE LUNAR SURFACE

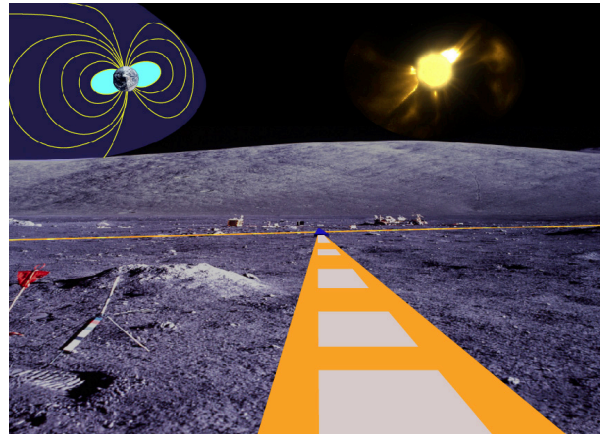
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Introduction: A low-frequency radio observatory on the lunar surface (L-ROLS) provides the capability to image solar radio bursts and other sources. Low-frequency observations (less than ~20 MHz) must be made from space, because lower frequencies are blocked by Earth's ionosphere. The ideal location for astrophysical, exoplanet, and cosmological sources is the lunar far-side, which provides a location free of radio frequency interference from terrestrial transmitters. For the more intense solar and terrestrial radio bursts, an observatory on the lunar near-side is feasible. Imaging those radio bursts would improve understanding of radio burst mechanisms, particle acceleration, and space weather. A logical approach would be to locate a pathfinder radio observatory on the near-side, utilizing the components planned for the far side observatory, for on-site testing and technical readiness confirmation. The lunar surface presents several severe challenges: large thermal variations associated with lunar day and night, the long lunar night ~ 14 days of darkness during which there is no solar array power, and deep space radiation levels that require radiation tolerant electronics. Therefore, a small pathfinder is a desirable precedent of the larger far-side radio observatory.

L-ROLS Pathfinder Mission Design: In this presentation we address key design elements of the pathfinder mission.

Commercial lander prospects. We are working with providers of commercial landing capabilities. Such landers can handle payloads up to 250 kg or more, which is more than the required mass for an L-ROLS pathfinder observatory. Some also provide rovers, which could be used for antenna deployment.

Antenna system. Although the concept of depositing antennas and the traces connecting them to the central processing hub on polyimide film, like the artist's concept shown above, is intriguing, potentially low mass, and possibly the simplest antenna system to deploy, it does not ensure a well-defined beam pattern that is critical for the far-side radio observatory. Therefore, L-ROLS should deploy antennas like those designed for the far-side array, which probably requires a rover, associated with the commercial lander. For L-ROLS, 16 to 24 antennas would be reasonable, whereas a far-side observatory would utilize 100 or more antennas, like ground-based arrays.



Power system. The mission lifetimes of lunar radio observatories should be more than 5 years, presenting major problems for powering them during the many lunar nights. We are currently investigating the future availability of a small radioisotope thermal generator (RTG) with a mass of ~50 kg to provide the needed power.

Thermal protection system. The electronics and other components must be protected from the thermal cycling on the lunar surface from ~ 120 deg to -170 deg C. The RTG would provide the current for the heaters necessary to ensure survival of the electronics and itself during lunar night. Thermal louvers and other techniques would be needed for cooling during lunar day.

Computation. For the necessary computation capabilities, we are currently investigating the GSFC Space CubeTM computer, a data-processing system that can handle 10^{11} bits per second (see <https://spacecube.nasa.gov/>). It is also radiation tolerant and low mass, which are desirable for a space mission to be landed on the lunar surface.

Data downlink. Because it might provide improved capabilities for Earth-Moon communication links, we are investigating the use of laser comm, which would provide a high data transfer rate requiring only low power that is ideal for imaging instruments.

We plan to complete the analysis of these design elements this year.